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(71) Applicant(s)
Motorola Limited

(Incorporated in the United Kingdom)

European Intellectual Property Operation, Jays Close, Viables Industrial Estate, BASINGSTOKE, Hampshire, RG22 4PD, United Kingdom

(72) Inventor(s)
Vernon Julian Fernandes

(74) Agent and/or Address for Service
Hugh Christopher Dunlop
Motorola Limited, European Intellectual Property Operation, Jays Close, Viables Industrial Estate, BASINGSTOKE, Hampshire, RG22 4PD, United Kingdom

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US 4541119 A

(58) Field of Search
UK CL (Edition M) **H3Q QAA QACA , H4L LDLX LDRSX LDSX LECX LERX LETXP LETXX**
INT CL^5 **H01Q 1/22 1/24 , H04B 1/03 1/036 1/08 1/38 7/00 7/155 7/24 7/26 , H04Q 7/04 , H05K 7/20 9/00**
Online databases:WPI

(54) Integrated base station and antenna mast

(57) The components of at least one base transceiver system are housed within an antenna support mast (10, Fig. 2). A base station controller may also be housed within the mast together with power supplies 50, 150, network terminators 55, 155, digital control circuits 60, 160, RF modules 65, 165, and power amplifiers 70, 170 for a two carrier system. Cooling is by internal convection, conduction through the body of the mast, and radiation, assisted by heat sinks 58, 158, heat pipes 56, 156, 63, 163 and heat spreaders 57, 157, 64, 164. A stirrer fan may also be provided at the bottom of the mast. The outer skin of the mast in the area around the electronics has insulation 45 against solar radiation. For high power systems, heat sinks may be attached directly to the body of the mast, with the neighbouring insulation 45 being removed. A sunshade (15) may be added.

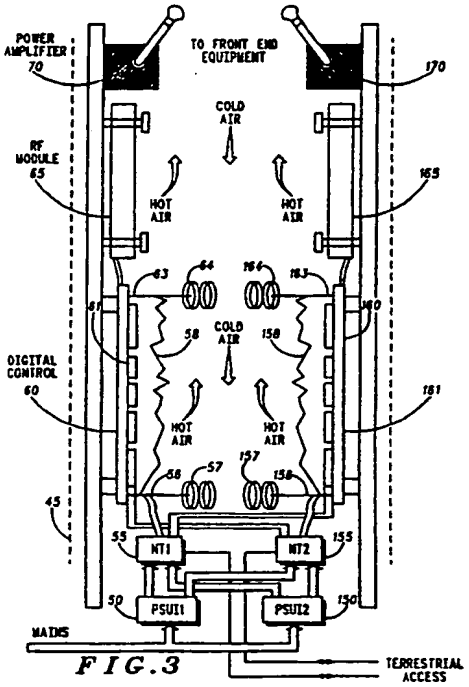

FIG.3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

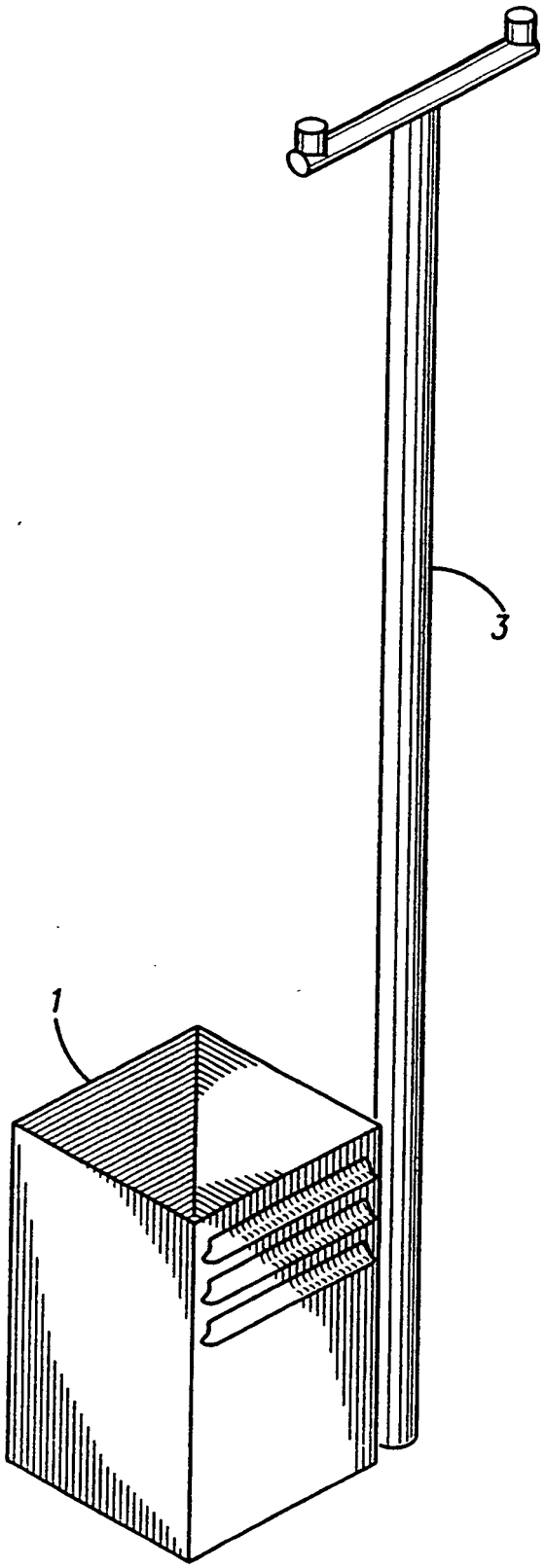

FIG.1

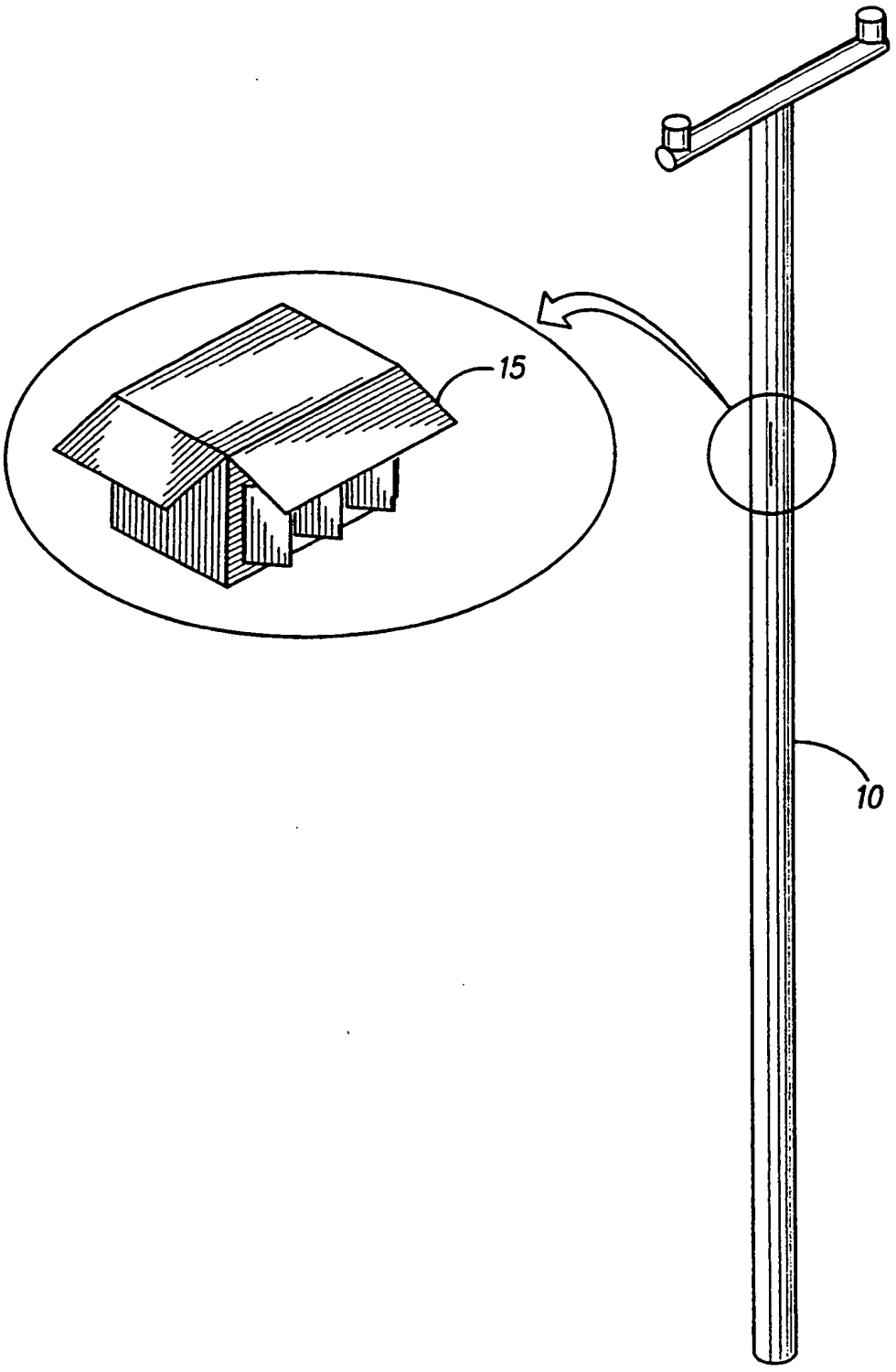

FIG.2

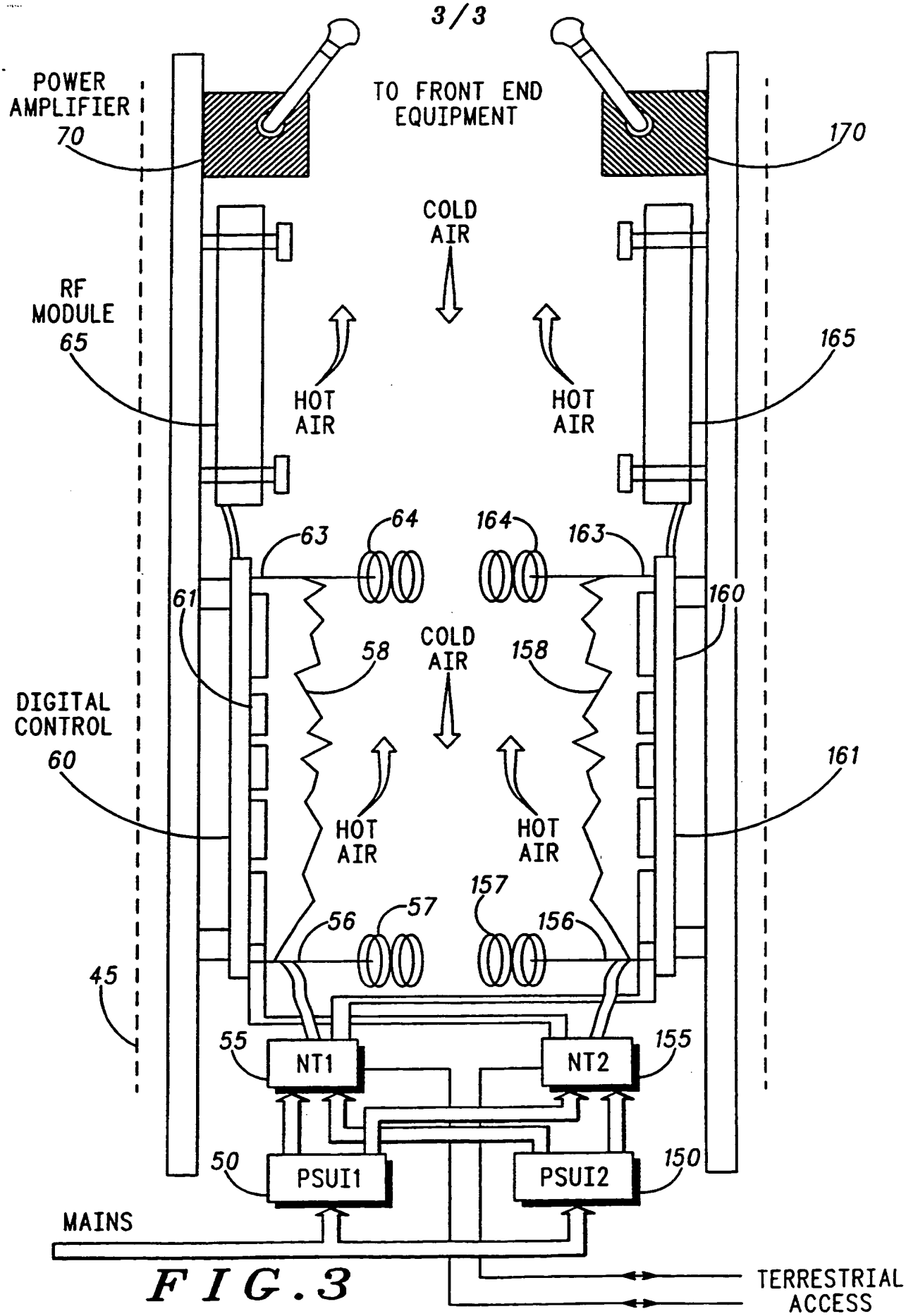
POWER AMPLIFIER
70
TO FRONT END EQUIPMENT
170
COLD AIR
RF MODULE
65
HOT AIR
HOT AIR
165
63
64
164
163
61
160
58
COLD AIR
158
DIGITAL CONTROL
60
161
HOT AIR
HOT AIR
157
56
57
156
45
55
NT1
NT2
155
50
PSUI1
PSUI2
150
MAINS
TERRESTRIAL ACCESS

FIG. 3

INTEGRATED MAST BASE STATION

Field of the Invention

This invention relates in general to base stations, and more particularly to an integral base station and antenna mast.

Background to the Invention

There is continuous pressure in the communications system market to reduce the size of communications equipment. There is also a growing requirement of communications systems operators to install communications equipment, particularly, base stations wherever the need may be including outdoors in both rural and urban areas.

In cellular communications systems, radio coverage in a defined geographical area is known as a cell and is handled by a base station which uses an adjoining antenna system to transmit and receive radio signals. The base station consists of a digital controller for site management, transceiver for RF modulation/demodulation, communications equipment for backhauling the data to a network controller and a power supply.

In standard operation a mobile station (MS) identifies the best candidate base station and locks on to the network via that base station. When a call is to be made the MS requests the allocation of a dedicated communications resource or channel to meet the nature of the call. Once a channel has been established signalling and traffic information can be exchanged between the network and the MS until the call is cleared. The availability of a communications resource is determined by the bandwidth available, the efficiency of the speech coding algorithm and the frequency reuse. As capacity demands increase the most common method to address the capacity requirement is to reduce the cell size and have greater frequency reuse. Smaller cell sizes imply a larger number of base stations, some of which will be of small capacity such as is the case with microcellular base stations.

The electronics in a cellsite is housed in a cabinet specified to meet the environmental conditions prevailing in the location selected for

installation. Often the location is outdoors and as such an integrated solution which meets the climatic, structural and EMC requirements has to be considered. Most commonly, prior art incorporates the electronics, communications equipment, power supply and heat management system (HMS) in a single cabinet or multiple cabinets which connects to an antenna fixed on top a mast. The size of the cabinet is constrained by the degree of integration of electronics and the heat dissipation which may require a heat exchanger to keep the internal temperature within acceptable limits defined by the rating of the electronic components.

FIG. 1 shows a base station which can be, as an example, a GSM Base Transceiver Station (BTS) within an integrated cabinet 1 that also accommodates all the ancillary equipment. Power would be fed to the cabinet by means of underground cables bearing ac mains. In the cabinet, a power supply module converts the mains to the dc voltages required to drive the electronics. The HMS is normally a heat exchanger that consists of internal and external air circuits. The air paths, created by fans, traverse a heat exchanging matrix commonly known as a recuperator. The power to the fans can be either at ac mains voltage driven or at dc voltage driven. The antenna mast 3 is next to the cabinet 1 and electrical connections are via underground cables.

From a physical design perspective it is important to reduce size and power. The greater level of integration made possible by ASICs and the use of lower voltage devices drive down the power to such an extent that it becomes feasible to use natural conduction and natural convection in the cooling of a system even in outdoor environments. This trend is applicable to both analogue and digital cellular base station systems. Smaller cabinets decrease the cost incurred by the operator by reducing the ground area leased by the operator.

Placing base stations outdoors reduces the costs attributable to leasing suitable premises and providing access to an antenna or plurality of antennas. Outdoor base stations typically include a cabinet placed along side of an antenna mast or mounted on a pole or mast used to support the antenna.

The difficulties of outdoor base stations are ensuring that the outdoor equipment is vandal proof and providing a suitable environment for the electronic components including cooling. Cooling implies the use of

moving parts, such as, expensive heat exchangers, air conditioners or fans. Such moving parts reduce the reliability of the base station equipment. Vandal proofing increases costs but is also made difficult since forced cooling requires vents or grills which compromise the security of the outdoor unit.

Thus there is a desire to have a base station located outdoors in a safe and suitable operating environment without increasing the overall cost or complexity of the base station equipment.

Summary of the Invention

According to the present invention an integral antenna mast and base station is provided for a communications system including an antenna for receiving and transmitting communications signals in the communications system and at least one base transceiver system integrally attached within the antenna mast having a connection to the antenna and having a connection to a base station controller.

Brief Description of the Drawing

FIG. 1 is prior art configuration of an antenna and base station.

FIG. 2 is an antenna mast with an integrated base station according to the present invention.

FIG. 3 a cross-sectional view of the antenna mast of FIG. 2.

Detailed Description of the Preferred Embodiment

The preferred embodiment of the present invention is described as an integrated antenna mast base station and takes the scale of integration of a cellsite to a level in which the need for an external cabinet for the base station is removed all together. The electronics in the preferred embodiment are housed inside the mast exploiting the EMC and environmental protection inherently provided by the mast body 10 as illustrated in FIG. 2. The comparatively large amount of space inside the mast body removes the space restrictions experienced if an external cabinet is used.

FIG. 3 shows the base station components within the antenna mast. The availability of powerful integrated circuits allows a single carrier base station to be constructed from a single digital card 60 and a single RF

analogue module 65 or other arrangements of similar electronics. The power amplifier (PA) 70 can be a separate module in the case of high power systems but can be integrated in the analogue card at lower (RF) powers. Access to the terrestrial network is via a network terminator (NT1) 55 which may be connected to a CEPT 2048 kbit/s link or an ISDN basic rate link or twisted pair subscriber loops. The PA connects to the transmit antenna.

It is possible to expand the concept to cover more than a single carrier base station within the antenna. In FIG. 3 a two carrier system is shown by way of an example. Here the power supply units (PSU's) are duplicated as (PSU1) 50 and (PSU2) 150, the network terminators are duplicated as 55 and 155, the digital control is duplicated as 60 and 160, the RF module is duplicated as 65 and 165 and the power amplifier is duplicated as 70 and 170. Power and backhaul communications links have underground access. Being a two carrier system, RF combining is required before the composite signal is fed to the antenna.

There are numerous mounting arrangements possible within the mast body which provides considerable scope for expansion and thermal management arrangements.

The invention provides a convenient means to cool the equipment by means of internal convection, conduction through the body of the mast and radiation. The arrangement of the system should be such that the heat generating electronics is placed well below the top of the mast. The outer skin in the area surrounding the electronics should be insulated from solar radiation otherwise considerable temperature elevation can be experienced under direct sunlight. The insulation 45 is shown as a dashed line in FIG. 3. The devices shall be placed such that heat is transmitted into the heat sinks 58, 158 from which it is convected into the inner atmosphere. Heat from the PCBs 61, 161 is also directed to the inner atmosphere by means of heat pipes 56, 156, 63, 163 and heat spreaders 57, 157, 64, 164 situated at the ends of the pipes. A laminar flow can be created as hot air rises along the side of the pipe and cooler air descends in the central section. Cooling of the hot air takes place at the top of the mast. The cooling system can be improved by adding air vents at the bottom and top of the pole but these should be designed to minimise water ingress and

make unauthorised access difficult. It is also possible to add an stirrer fan at the bottom of the pole to encourage air flow.

For the case of high power PAs in which considerable heat is dissipated and alternative heat management scheme is to attach the heat sink directly onto the body of the mast and remove the neighbouring outer insulation. If solar radiation gain is a factor then a sunshade 15 as shown in FIG. 2 may be added.

Integrating further components of the cellular system so that they may be located within the antenna mast is within the scope and spirit of the present invention. For example, integrating a base station controller or parts thereof may be a possibility.

The present invention provides a suitable means of removing the need for an external cabinet of a base station located in a cellsite and reducing the externally viewed hardware to that of the antenna mast and the antenna itself which is situated on top of the mast. Due to the normal size of the mast, in terms of cross-sectional area and height, considerable freedom in designing for thermal management is available. This degree of freedom is not available in the implementation of external cabinets since size reduction is paramount. The benefits accrued by the invention cover reduced cellsite real estate, reduced site costs, integral vandal protection, EMC protection and low cost thermal management.

Claims

1. In a communications system, an integral antenna mast and base station comprising:

an antenna mast having an antenna connected thereto for receiving and transmitting communications signals in the communications system; and

at least one base transceiver system integrally attached within the antenna mast having a connection to the antenna and having a connection to a base station controller or network.

2. The integral antenna mast and base station of claim 1 further comprising an integral base station controller.

3. The integral antenna mast and base station of claim 1 wherein the base station includes heat sink components that are attached to an inner wall of the antenna mast.

4. An integral base station and antenna substantially as herein described with reference to FIG. 3 of the drawing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(T Search report)

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Relevant Technical Fields

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(ii) Int Cl (Ed.5) H01Q 1/22, 1/24; H04Q 7/04; H05K 7/20, 9/00; H04B 1/03, 1/036, 1/08, 1/38, 7/00, 7/155, 7/24, 7/26

Search Examiner
M J BILLING

Date of completion of Search
24 AUGUST 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE: WPI

Documents considered relevant following a search in respect of Claims :-
1-3

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	US 4541119	(COOPER) eg see Figures 3, 4, 10; column 5 lines 22-64	1 at least

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).